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ON THE IDENTIFICATION OF FISH ARTIFICIALLY HATCHED.

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ALTHOUGH the United States Fish Commission has annually hatched and planted many millions of young fish, and although the planting has often resulted in the apparent increase in the number of adults where the plantings have been made, there is nothing but circumstantial evidence to show that the fish appearing in increased numbers are really the adults of the young artificially produced. The recent excessive abundance of cod along the shores of New England is probably the result of extensive operations at the Woods Holl hatchery. The facts that these fish were small when they first appeared, that they have since increased in size, that they have occurred in localities where cod had never before been caught, and that they are reported to be of a different color from the native variety are interesting, although to the sceptical they are not absolutely convincing. There is need of some scheme whereby the adults of fish hatched artificially may be distinguished from those native to the locality.

To mark the fry is, of course, out of the question, but is it not possible that the fry mark themselves, *i.e.*, is there not a slight difference between the fish of the same species but of different localities, and if there is this slight difference, does it not present itself in a measurable manner?

The careful examination of a large number of periwinkle shells¹ (*Littorina littorea*) has shown that localities even near together are characterized by shells of different proportions. This fact has warranted the examination of a number of fish for the purpose of seeing if they too are not subject to similar varietal changes.

During the latter part of March of the present year, while

¹ *Zoölogical Bulletin*, vol. i, No. 5, February, 1898, p. 247.

at the Laboratory of the United States Fish Commission, I examined several hundred winter flatfish (*Pleuronectes americanus*) with the following results :

Of 100 flatfish collected at Woods Holl, only one had 62 dorsal fin-rays, seven had 63, twelve had 64, twenty-two had

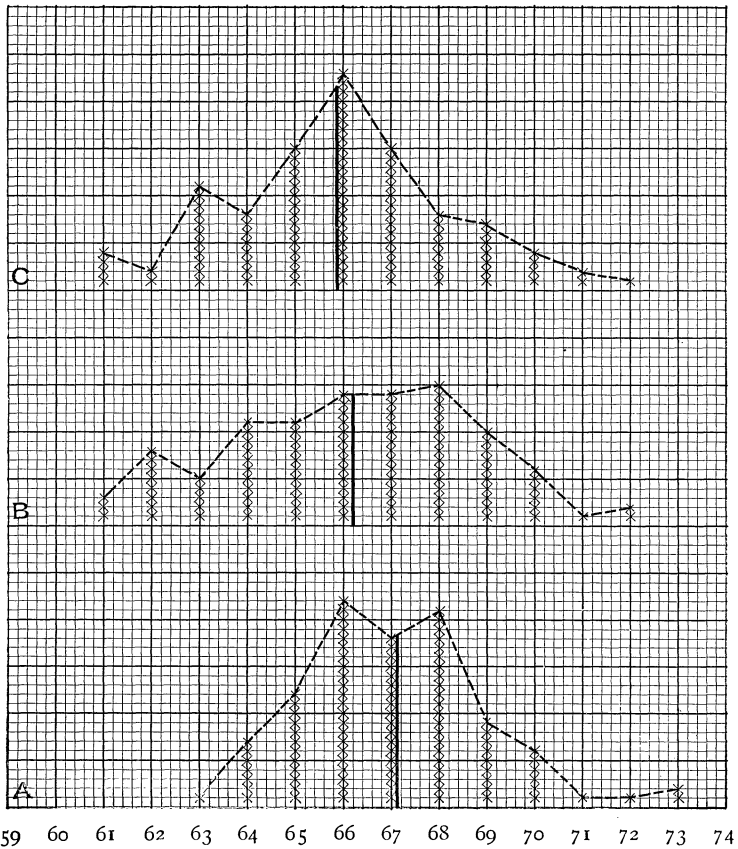


FIG. 1.

65, etc., as represented by the ordinates of curve *A* in Fig. 1. The amplitude of variation is between 62 and 72, the arithmetical mean being 66, represented by the vertical line at the right of 66.1, curve *A*. The curve drawn through the upper ends of the ordinates represents graphically the distribution of the 100 variants around this mean.

If we now tabulate the dorsal fin-rays of an equal number of flatfish from another locality, it is evident that if the fishes in both localities are alike, the curves will coincide. If they are different, even slightly so, the lack of coincidence will indicate the difference. The curve drawn at *B*, Fig. 1, is based on the enumeration of the dorsal fin-rays of 100 flatfish taken at Waquoit, Mass., from a small bay only eight miles east from Woods Holl. Compared with curve *A*, the Waquoit curve lies further to the left, has a longer base, and a less altitude. The Waquoit collection thus contains several fish, the number of dorsal fin-rays of which are less in number than those of fish taken at Woods Holl. The Waquoit fish are more variable, the amplitude at Woods Holl being from 62 to 72 (eleven points), while the amplitude at Waquoit is from 60 to 71 (twelve points). The depressed curve of distribution in the second curve is an indication of greater variability and general indifference to the "ideal mean." The arithmetical mean, represented by the vertical line, is 65.2, the Waquoit fishes averaging about one dorsal fin-ray less than the Woods Holl specimens.

Curve *C* represents the distribution of 100 flatfish from Bristol, R. I., from a body of water located about fifty miles west of Woods Holl. Compared with curve *A*, the Bristol curve lies further to the left and has a broader base, though its culminating point is very definitely indicated. The arithmetical mean is 64.9.

It is thus seen that there is a measurable difference between collections of fish from different localities, even though the fish *individually* present no perceptible difference.

There is correlated with the increase or decrease in the number of dorsal fin-rays, an increase and decrease in the number of anal fin-rays, as shown in Fig. 2. The Woods Holl specimens average a large number of dorsal and also a large number of anal fin-rays, 66.1 dorsals and 49.7 anals. The Waquoit specimens average a less number of dorsal fin-rays (65.2), and they also have a less number of anal fin-rays (48.6). The Bristol specimens average only 64.9 dorsal fin-rays and 48.7 anal fin-rays. The individuals also partake of this corre-

lation, those having a larger number of dorsal fin-rays tending towards the possession of a larger number of anal fin-rays.

If it is proposed to test the result of re-stocking a locality in which a species of fish has become reduced in numbers, it is necessary to first determine the "curve of distribution" from

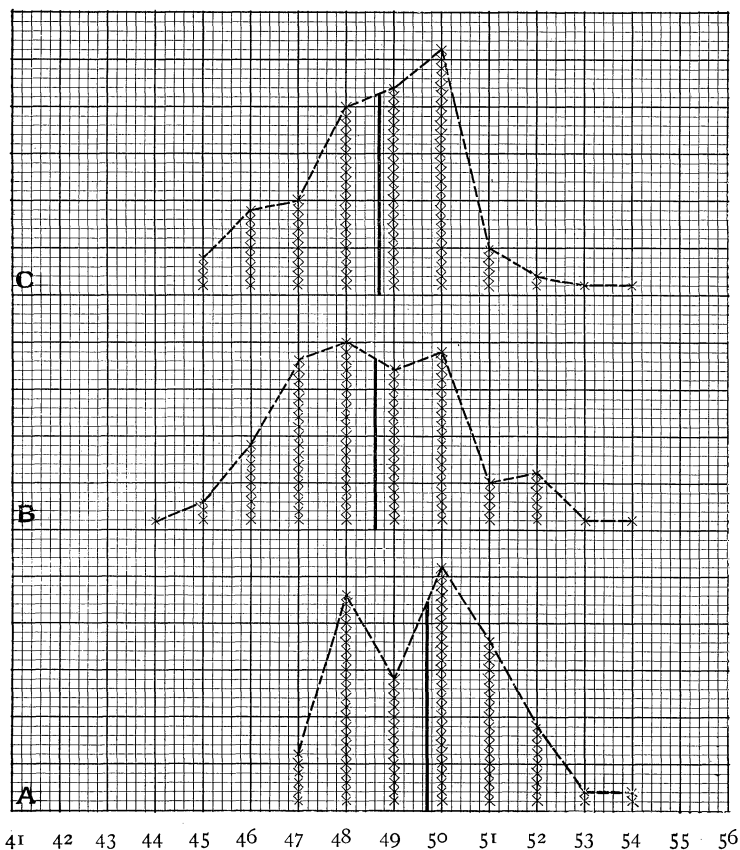


FIG. 2.

fish native to the locality, and this curve may be based on any measurable structural character, such as the number of fin-rays, the number of scale-rows, or the number of vertebræ. One must then determine the "curve of distribution," for the same structural character, of fishes of the same species, but abundantly found at another locality, from which the "brood fish"

are to be taken. After the "planted fish" have had time to mature, new curves should be plotted for the first locality. If these curves are practically the same as those originally made, it is reasonable to conclude that the re-stocking has been ineffectual. If, however, the new curve approaches the curve of the locality from which the "brood fish" were taken, it is reasonable to conclude that the influence of the foreign specimens has been felt, and the re-stocking has been effectual.

The following objections may be raised to the above method :

(1) It may be that, due to the small number of specimens (100), the curve *A* is not characteristic of the Woods Holl specimens, and its difference from curve *B* is only accidental. To test this source of possible error I have examined three separate groups of flatfish, all from the same locality, each group containing 100 specimens. The resulting curves are strikingly alike. Of course it would be much more satisfactory to base all the curves on the enumeration of the fin-rays of one thousand rather than one hundred specimens, but even one hundred specimens yield fairly definite results, though the curves are somewhat uneven.

(2) It may be that the variation in the position of the curves is a result of age, *i.e.*, the fishes from Woods Holl averaged a larger number of fin-rays because they were somewhat older.

If there is an increase in the number of fin-rays on the part of the older specimens, this increase can be readily detected by simply comparing the average number of fin-rays of the younger with the average number of fin-rays of the older fish. Fifty-three young fishes, less than 10 inches in length, have a mathematical average of 66.1 dorsal fin-rays. Forty-seven older fishes from the same locality, all over 10 inches in length, average practically the same number of fin-rays, *i.e.*, 66.3. In this collection of 100 fishes, the fourteen smallest have a greater average number of fin-rays than the fourteen largest. There is then no material increase in the number of fin-rays with increase in age.

(3) It may be that the variations tabulated in Fig. 1 are the result of environmental conditions expressed upon the fry and young — acquired characters of questionable hereditary value ;

i.e., it may be that the fry reared at Woods Holl would attain to a larger number of dorsal fin-rays than the *same* fry reared at Waquoit.

While certain experiments that the writer has made induce him to believe that these variations in the number of dorsal fin-rays may be deep-seated blastogenic characters, the influence of the environment, even if it should affect the ontogenic process, cannot vitiate the method, for if it is insisted that certain external influences may affect the fry *after* liberation from the hatchery, and the results of these influences are expressed by a change in the fin-ray formula, it must also be equally true that the more extreme and unusual environmental conditions imposed upon the still younger organism while *within* the hatchery, will leave their stamp also, and the artificially hatched fish will thus present some peculiarity, acquired though it may be, which will be brought out by the plotting of "curves of distribution."